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Assessment of the 1984 fishery for snow crab off the Atlantic Coast of Cape Breton Island

by

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Abstract

Biological assessments are presented for the 1984 Cape Breton Island (Atlantic coast, areas 2-6) snow crab fishery, based on data derived from fishermen's logbooks, sales slips statistics, commercial and research catch sampling.

Overall, for the 1984 season, a continued high market demand for crab failed to maintain fishing effort (trap hauls) at 1983 levels. Severely reduced effort coupled with low catch rates, relative to historical levels, resulted in total recorded landings (141 MT) from the 51 active fishermen, falling to 46% of the 1983 value (307 MT). Analyses of 1984 logbooks indicate that exploitable stock abundances have been further depressed in most areas since 1983. No soft-shell crab were found during commercial catch sampling in areas 3 and 5, indicating that no in-season growth and recruitment occurred. Similarly, comparisons between end of 1983 season commercial biomass estimates with estimates for the start of 1984 season indicate no major inter-season pulses of growth and recruitment for any area. Data from area 5 show a declining incidence of ovigerous females from close to 100% in 1982 to 75% in 1984.

As noted for previous years, given high exploitation rates and the continued absence of major production in areas 2-6, it appears inevitable that exploitable stock abundances and catch rates will continue to decline. The future of the snow crab fishery off the Atlantic coast of Cape Breton Island will depend on market demand and production patterns. With the present low catch rates, a decrease in price paid to fishermen could make fishing uneconomical; on the other hand, prices notwithstanding, a continued lack of production will lead to the practical extinction of the resource and fishery.

Résumé

On présente des évaluations biologiques concernant la pêche au crabe des neiges en 1984 dans la région de l'île du Cap-Breton (côte atlantique, régions 2-6) fondées sur des données provenant des journaux de bord, des borderaux d'achat et de l'échantillonnage des prises des navires commerciaux et des navires de recherche.

Globalement, on peut dire que malgré une demande soutenue sur le marché pour le crabe des neiges, l'effort de pêche (casiers relevés) au cours de la saison 1984 ne s'est pas maintenu aux niveaux de 1983. Une baisse marquée de l'effort de pêche combinée à des taux de capture faibles comparativement aux années antérieures ont eu pour effet que les débarquements totaux enregistrés par les 51 pêcheurs actifs (141 tonnes métriques) ne représentaient que 46 % de la valeur de 1983 (307 tonnes métriques). L'analyse des journaux de bord de 1984 a indiqué que l'abondance des stocks exploitables avait encore diminué dans la plupart des régions depuis 1983. Aucun crabe à carapace molle n'a été trouvé au cours de l'échantillonnage des prises commerciales dans les régions 3 et 5, ce qui indique qu'il n'y a pas eu de croissance ou de recrutement durant la saison. De même, la comparaison des estimations de la biomasse commerciale entre la fin de la saison 1983 et le début de la saison 1984 indique qu'il n'y a pas eu de poussée importante de croissance ou de recrutement entre les saisons, quelle que soit la région. Des données de la région 5 montrent une baisse de la fréquence des femelles porteuses d'oeufs, qui est passée de près de 100 % en 1982 à 75 % en 1984.

Comme on l'a noté au cours des années antérieures, étant donné des taux d'exploitation élevés et l'absence continue de production importante dans les régions 2-6, il apparaît certain que l'abondance des stocks exploitables et les taux de capture continueront de diminuer. L'avenir de la pêche au crabe des neiges près de l'île du Cap-Breton sur la côte atlantique dépendra des caractéristiques du marché et de la production. Avec les faibles taux de capture actuels, une baisse du prix payé au pêcheur pourrait rendre cette pêche non rentable; par ailleurs, malgré le prix, l'absence continue de production finira par entraîner à toute fin pratique la disparition de cette ressource et de cette pêche.

Introduction

The directed fishery for snow crab around Cape Breton Island was started in 1966 by inshore boats trapping off the northwest coast. Between 1977 and 1979, landings rose markedly in phase with effort and the expansion of the fishery to approximately 180 inshore vessels operating around most of the Island (Elner 1982). Between 1976 and 1978, six inshore areas were defined around Cape Breton Island (Fig. 1) for exclusive exploitation by inshore boats under 45 ft (13.7 m) in length. One hundred and fifty snow crab licenses were issued to inshore boats to fish these areas in 1981. Additionally, 28 licenses were allotted for inshore boats to fish area 7 off the SW coast; area 7 is also open to the New Brunswick and Quebec offshore crab fleets.

By 1982 it became apparent that the snow crab fisheries on the Atlantic coast of Cape Breton Island (areas 2-6, Scotia-Fundy Region) are based on a resource which has a low productivity and that the accumulated virgin biomass had been drastically reduced by fishing. In contrast, on the Gulf of St. Lawrence coast of the Island (areas 1 and 7, Gulf Region) larger production levels have conferred relative stability to the commercial biomass and landings (Elner 1982). As the productivity of the Atlantic coast resource appeared too low and erratic to allow for a strategy of biomass stabilization, management dropped catch controls for the fishery in 1982 to allow existing fishermen to take advantage of whatever productivity occurs from time to time on an opportunistic basis. The minimum legal size regulation (95 mm carapace width, CW) is hypothesized to confine exploitation to mature males that have had 1-3 yr to mate and, thus, the reproductive potential of the resource is believed to be protected (Elner and Robichaud 1983a; Elner and Gass 1984).

Based on fishermen's logbooks, sales slips statistics, commercial and research catch sampling, this paper assesses the status of the snow crab fishery in areas 2, 3, 4, 5, and 6.

Methods

Since 1978, Cape Breton Island snow crab fishermen have been required to maintain logbooks. To improve trap location information in logbooks, fishermen were given new large-scale grid charts in 1983 and requested to indicate the grid number(s) corresponding to their fishing area(s).

Biomass estimates for each area were made, where possible, by Leslie analysis, plotting cumulative catch (x-axis) at weekly intervals against mean CPUE (kg.trap haul^{-1}), from logbook data (Ricker 1975). No attempt was made to standardize trap soak times which ranged: 1-5 soak days (mean 1.6 d) for area 3, 1-6 soak days (mean 2.0 d) for area 4 and 1-4 soak days (mean 2.1 d) for area 5. The slope of the linear regression gives an estimate of the catchability (q) of the gear. The intercept of the regression line on the x-axis gives an estimate of the total biomass (B_o) above legal minimum CW available for the fishing season. Assuming that natural mortality is not significant during the relatively short fishing season (i.e. a type I fishery, Ricker (1975)), the rate of

exploitation (U) is given by:

$$U = \frac{Y}{B_o} \quad \ldots\ldots\ldots\ldots\ldots\ldots (1)$$

where Y is the total catch.

If q is assumed to be constant throughout the fishing season, it is possible to calculate the biomass (B_t) present at a given time, knowing the CPUE value at that time ($CPUE_t$), from:

$$\frac{CPUE_t}{q} = B_t \quad \ldots\ldots\ldots\ldots\ldots\ldots (2)$$

Equation (2) makes it possible to estimate biomass increases from growth and recruitment during the fishing season. Significant molting periods leading to growth and recruitment are detectable by in-season rises in mean CPUE and simultaneous increases in the observed frequency of soft-shelled crabs in commercial catch samples.

Ricker (1975) gives a detailed account of possible sources of discrepancy in Leslie analyses.

In area 5, between September 27 and 29, 1984, male and female snow crabs were caught by trapping from a commercial snow crab vessel under charter in the area bounded by:

Latitude (N)	Longitude (W)
45°42'00"	59°55'00"
45°42'00"	59°51'00"
45°39'00"	59°54'00"

To investigate longer-term reproductive patterns, female snow crabs were tagged with either t-bar tags or spagetti tags prior to release. The t-bar tags (molting-cone type) were injected through the right end of the posterior suture-line and designed to be retained through ecdysis. The spagetti tags were tied around the carapace and cannot be retained through ecdysis. Fishermen are relied upon to return all tags recovered. A $2.00 reward is given the finder for each tag returned with details of how, where, and when the capture was made. An additional reward of $2.00 is offered for tagged crabs that are made available for measurement.

Port and at-sea sampling of commercial landings was carried out throughout the fishing season in area 5, and to a more limited extent in areas 3 and 6, to assess catch size-frequency distribution and shell hardness. Manpower shortages precluded sampling in areas 2 and 4.

Results

The 1984 fishing season was from July 22 to September 15 for areas 2, 3, 4 and 5, and August 1 to September 31 for area 6. The average CPUE for each grid square and the distribution of fishing effort from logbook data in 1984 is shown in Fig. 2.

A summary of snow crab landings, effort statistics, and assessment estimates for each area since 1978 is given in Tables 1 and 2.

Areas 2, 3, and 4 (northeast Cape Breton)

Since 1980, snow crab areas 2[1] and 3, plus the nearshore portion of area 4 (being adjacent, relatively small management areas with a paucity of landings and commercial catch statistics) have been treated as a single stock for the purpose of annual assessments.

Port and at-sea sampling

Due to the relatively low landings in areas 2, 3, and 4, sampling manpower was largely diverted to the more important area 5 fishery. Port samples for area 3 in July and August are shown in Fig. 5. Shell condition data (Fig. 6) indicate that most crabs landed were hard-shelled, suggesting that there was little growth and recruitment through the 1984 season.

Logbooks

Only scanty fisheries information was forthcoming from area 2. No logbooks were received from the 5 licensed fishermen, although sales slips indicate that 2 fishermen caught 9593 kg (Tables 1, 2).

Logbooks, recording landings of 12,839 kg, were received from 13 of the 19 active fishermen in area 3. For the purpose of the following Leslie analysis, logbooks from 3 fishermen from area 4 who fished in, or adjacent to, area 3 have been included with the area 3 logbooks. CPUE, plotted against cumulative catch, demonstrates a steep decline through the fishing season, indicating that no significant biomass pulses occurred during this period (Table 3, Fig. 3). A linear regression through all data points gives an estimate for total available biomass (B_0) of 24.2 MT (95% confidence limits: 18.7 and 45.1 MT). By subtraction of the 1984 catch for area 3 and part of area 4, 16.4 MT (from logbook data), we calculate that 7.8 MT (95% confidence limits: 2.3 and 28.7 MT) of commercial crab were left on the grounds when the fishery closed. Given that natural mortality was not significant during the fishing season, this fishery is experiencing an exploitation rate of 68% (95% confidence limits: 88% and 36%). Elner and Robichaud (1984) observed a similar pattern and level of catch rates for this fishery in 1983 and estimated that the total available biomass for the similar area was 76.5 MT (95% confidence limits: 69.5 and 87.2 MT); the exploitation rate was calculated at 72% (95% confidence limits: 63% and 80%). The estimated end of season biomass in 1983 of 21.3 MT is 2.9 MT below the biomass available for the 1984 season; suggesting that little growth and recruitment occurred between the two seasons.

Six out of 7 fishermen from area 4 who fished during 1984 returned logbooks detailing catches of 18,141 kg; 17,581 kg was landed according to statistics from sales slips. A Leslie analysis for the whole of area 4 is inappropriate because the landings of 3 fishermen were included in the area

[1]Area boundaries revised for 1984 season.

3 analysis. Table 4 summarizes logbook data from the 3 fishermen setting traps offshore and away from the area 3 boundary in area 4 and demonstrates a slow decline in CPUE (17.61 to 9.37 kg·trap haul^{-1}) through the fishing season. A Leslie analysis (Fig. 4) using all data points gives an estimate for total available biomass (B_o) of 28.3 MT (95% confidence limits: 22.8 and 41.1 MT). By subtraction of the 1984 catch, according to logbooks (14.6 MT), 13.7 MT (95% confidence limits: 8.2 and 26.5 MT) remained on the offshore area 4 grounds at the end of the 1984 season. Exploitation rate is estimated at 51% (95% confidence limits: 64% and 35%) for the season. Comparative CPUE's for 1983 ranged from 17.0 to 2.5 kg·trap haul^{-1}, and suggest that the offshore resource in area 4 has been relatively stable over the past two fishing seasons; however, current catch rates remain considerably below historical levels (Table 2).

Area 5 (southeast Cape Breton)

Port and at-sea sampling

Size-frequency histograms from port sampling during July and August and at-sea sampling during August are shown in Fig. 7. Mean carapace widths from both port and at-sea sampling appeared to decrease through the fishing season. A post-season, at-sea sample of 2581 snow crabs was taken in September 1984 by a commercial vessel under charter (Fig. 8). Comparison of commercial catch size-frequency distributions since 1978 demonstrate a trend for decreasing crab size over the past 2 years (Fig. 9).

The absence of soft-shell crabs and the low incidence of intermediate-shell crabs (Fig. 6), as determined from port and at-sea sampling, suggests that molting and growth were not prevalent within the 1983 fishing season. In-season growth and recruitment has not been apparent in area 5 over the period 1978-84 (Elner 1982; Elner and Robichaud 1983b; Elner and Robichaud 1984).

Logbooks

Logbooks were received from 6 of the 10 area 5 fishermen who set traps in 1984. Total landings derived from logbooks were 41,295 kg, as compared to 45,215 kg from sales slips statistics (Table 2). Comparison of CPUE through the 1984 fishing season for individual vessels (Fig. 10) reveals a diverse array of patterns. Such high inter- and intra-vessel variability in fishing success probably reflects the searching behavior of fishermen faced with a dispersed, low-density resource interspersed with occasional higher density "pockets" of crab. Indeed, because of the low fishing success, there was a response by some fishermen to search for higher densities of crab further offshore on previously unexploited grounds. The high early-season catch rates experienced by one vessel (total landings for season: 12.2 MT) indicated in Fig. 10 reflects this expansion of the fishing grounds. However, although the modifying influence of the offshore expansion should be remembered in the following considerations of biomass, catch rates and landings, its impact does not alter the underlying pattern of stock dynamics for area 5. Essentially, the area 5 snow crab stock, historically the major snow crab fishing area on the Atlantic coast of Cape Breton Island, appears to have suffered a prolonged recruitment failure and must be considered collapsed.

Mean CPUE declined rapidly through the 1984 fishing season (Table 5; Fig. 11). The overall mean CPUE value for the season (17.68 kg·trap haul^{-1}) was below those estimated for 1983 (20.50 kg·trap haul^{-1}) and 1982 (33.73 kg·trap haul^{-1}). The 1984 CPUE pattern appears "dwarfed" by those of 1978-83 (Fig. 12). Landings in 1984 (45.2 MT) were well below those of 1983 (151.3 MT) and there was also a drastic reduction in effort between the two years (7261 vs. 2336 total trap hauls for the 1983 and 1984 seasons, respectively). The decreases in landings and effort have occurred despite relatively high prices paid to fishermen for snow crab (1981: $0.25/lb ($0.55/kg); 1982: $0.65/lb ($1.43/kg); 1983: $0.90/lb ($1.98/kg); 1984: $0.65/lb ($1.43/kg)).

A Leslie analysis of all the 1984 logbook data from area 5[2] (Table 5; Fig. 11) indicates a total available biomass (B_o) for the season of 55.3 MT (95% confidence limits: 50.8 and 61.5 MT). By subtraction of the landings (41.3 MT) from B_o, an estimated 14.0 MT (95% confidence limits: 9.5 and 20.2 MT) of commercial crab remained on the fishing grounds at the close of the 1984 season after an exploitation rate of 75% (95% confidence limits: 81% and 67%). In comparison, a biomass of 27.2-96.1 MT was variously estimated to remain on the grounds at the end of the 1983 season (Elner and Robichaud 1984). The estimate of biomass available for the 1984 season falls within the estimated biomass range at the end of the 1983 season and further evidences the dearth of stock production (notwithstanding the postulated offshore expansion of the fishing grounds).

Tagging (growth and reproduction studies)

With the obviously depressed state of all the Atlantic coast of Cape Breton snow crab stocks emphasis has shifted from annual stock monitoring and assessment programs to longer-term basic research into stock dynamics and biology. Hence, mark-recapture techniques are being utilized to elucidate growth and reproductive biology rather than for biomass estimates. The following summarizes aspects of the longer-term tagging research for 1984.

Seventeen (17) and 94 male snow crabs marked with t-bar tags and released in 1982 and 1983, respectively, were recaptured during the 1984 fishing season in area 5 (Table 6). Of the 7 crabs measured (range: 99-120 mm carapace width (CW)) for the 1983 returns, only one had increased in size (102 to 125 mm CW) and the one crab measured (114 mm CW) for the 1982 returns had not grown.

Two hundred and ninety-six (296) male and 2285 mature female snow crabs were trapped on the post-fishing season charter in September 1984 (Fig. 8). Five hundred and twenty-six (526) mature females were marked and released (t-bar tag: 504; spagetti tag: 22) (Fig. 13). Five hundred and twenty-three (523), 23%, of the females trapped were barren (Fig. 8) and a large proportion of the 1762 ovigerous females appeared to have reduced clutch sizes. (There appeared no relationship between female CW and barren state, Fig. 8.) In addition, most of the females had heavily fouled and aged

[2]Note, exclusion of the fishing vessel operating part of the season offshore would reduce B_o to 34.6 MT (95% confidence limits: 22.7 and 171.4 MT).

carapaces; many had missing appendages. Elner and Robichaud (1983a) showed a reduction in ovigerous female incidence (to 90%) in area 5 in 1983; our present 1984 data appears to confirm a trend for a declining incidence of ovigerous females (Fig. 14). Overall evidence suggests that the long-term lack of recruitment to area 5 is resulting in stock senescence and extinction: males of commercial size are rapidly being extinguished and females are becoming either too old to reproduce or are failing to copulate. Further in-depth analyses of reproductive condition are underway on approximately 400 females and 80 males that were preserved and brought back to the laboratory.

Area 6 (south Cape Breton)

In 1983, five additional fishermen from Canso were allowed to trap snow crab on previously unexploited grounds in area 6. In terms of landings, area 6 eclipsed area 5 in 1984 to become the major snow crab area on the Atlantic coast of Cape Breton; however, CPUE, relative abundance indices (Table 2), suggests that area 5 still retains a denser population of commercial-sized snow crab than area 6.

Port and at-sea sampling

The one port sample obtained from area 6 during the 1984 fishing season (Fig.15) demonstrates a bimodal distribution.

Logbooks

The total landings from 12 logbooks received from the 13 area 6 fishermen in 1984 amounted to 50,239 kg, as opposed to the 53,889 kg recorded through the sales slips' statistics system.

An initial slow decline in CPUE was reversed during the latter part of the 1984 season so that, overall, CPUE remained low but relatively stable (Table 7; Fig. 16). CPUE values dropped under 10.0 kg·trap haul^{-1} for the third year in succession; however, the overall mean CPUE value for the season (9.61 kg·trap haul^{-1}) was 13.5% above the 1983 value of 8.47 kg·trap haul^{-1}. A Leslie analysis of 1984 logbook data is impractical due to the shape of the mean CPUE vs. cumulative catch pattern (Fig. 16). As noted for previous assessments (Elner and Robichaud 1983b, 1984), it appears that the failure of CPUE to decline through the season is an artefact of fishing dynamics on a low-density, dispersed resource: fishermen are obliged to continually move their traps in search of small "pockets" of crab, resulting in a flat CPUE pattern that is not amenable to resolution by Leslie analysis.

Direct comparisons between the area 6 commercial biomass level in 1984 and previous years are confounded due to the expansion of the fishing grounds by the Canso entrants and the lack of a Leslie biomass estimate for 1984; however, historical trends in overall mean CPUE values, relative abundance indices (Table 2), indicate that landings have outweighed production and the exploitable biomass is becoming diminished. Nevertheless, as 38.2 MT (95% confidence limits: 24.2 and 61.8 MT) of commercial crab were estimated to remain on the fishing grounds at the close of the 1983 season (119.9 MT (95% confidence limits: 61.9 and 283.7 MT) were estimated to remain at the end of the 1982 season) and over 50 MT was landed

during 1984 with little change in CPUE, it is evident that either there is some production on the grounds or new fishing areas are still being discovered.

Discussion

In 1982, CAFSAC determined, given the low catch rates prevailing in areas 2-6, the resultant scanty data produced for assessment purposes, and limitations in the assessment techniques themselves, that provision of advice to management on annual TAC levels was not feasible. Certainly, the assessments for the 1984 season do not appear cause for change in CAFSAC's decision and, thus, there appears no rationale for re-introducing catch controls for the 1985 season.

Overall, the 1984 stock status for areas 2-6 appears to be a further degeneration of the depressed state noted in 1981, 1982 and 1983 (Elner and Robichaud 1984). No major pulses of growth and recruitment were detected in the system during the fishing season. The price paid for snow crab failed to maintain effort. In turn, the overall decrease in effort and reductions in CPUE have resulted in a decrease in total landings.

Although (given sparsely distributed stocks and incomplete statistics) our assessments are at the boundaries of feasibility, it appears unlikely that even the present marginal CPUEs can be retained in the face of high exploitation rates and the continued absence of major growth and recruitment. The viability of the 1984 fishery was considerably enhanced by the continued strong world market demand for crab maintaining relatively high prices.[3] The future of the snow crab fishery on the Atlantic coast of Cape Breton Island will depend on the world market situation and recruitment patterns. With the present low CPUE levels, a decrease in the price paid to fishermen could lead to the cost of fishing rising above income and an abandonment of the fishery. On the other hand, notwithstanding prices, a continued lack of growth and recruitment must lead to the practical extinction of the resource and fishery.

Acknowledgements

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[3]Due largely to collapses of the Alaskan king and tanner crab fisheries.

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Table 1. Snow crab statistics for the Atlantic coast of Cape Breton Island, 1978-84.

Area	Year	No. of boats licensed	No. of active boats	No. of logbooks received	Statistics landed: area managers (kg)	Statistics landed: logbooks (kg)	Actual effort in traps hauled (from logbook data) (all trap types combined)
2	1978	-	-	-	-	-	-
	1979	12	8	3	108,005	14,129	1,739
	1980	12	8	3	46,919	10,240	1,276
	1981	13	6	-	4,695	-	-
	1982	13	-	-	-	-	-
	1983	13	12	2	7,130	248	150
	1984	5	2	-	9,593	-	-
3	1978	36	16	16	-	91,118	7,863
	1979	36	27	27	185,101	164,110	18,124
	1980	36	31	25	139,686	73,988	13,835
	1981	36	22	1	31,215	816	60
	1982	35	20	18	86,814	75,295	9,388
	1983	35	27	27	40,058	40,172	8,217
	1984	37	19	13	14,649	12,839	4,346
4	1978	38	11	11	-	305,076	11,268
	1979	38	35	26	624,029	591,580	22,775
	1980	38	26	18	181,241	136,605	7,543
	1981	37	11	3	61,476	6,545	520
	1982	37	21	20	165,395	116,243	6,138
	1983	38	24	18	44,199	31,612	4,341
	1984	37	7	6	17,581	18,141	2,173
5	1978	15	15	15	-	250,076	6,165
	1979	25	24	23	679,504	682,731	15,382
	1980	26	24	21	395,855	324,786	9,261
	1981	25	11	10	90,463	81,819	3,135
	1982	25	19	18	300,145	298,469	9,931
	1983	22	21	21	151,296	148,827	8,146
	1984	24	10	6	45,215	41,295	2,220
6	1979	8	4	4	24,868	27,351	1,880
	1980	11	10	9	58,586	69,136	5,246
	1981	11	5	5	15,896	20,350	1,316
	1982	11	7	7	63,072	63,133	6,462
	1983	14	13	12	64,084	64,461	7,733
	1984	14	13	12	53,889	50,239	5,229
TOTAL	1978	89	42	42	-	646,270	25,296
	1979	119	98	83	1,621,507	1,479,901	59,900
	1980	123	99	76	822,287	614,755	37,161
	1981	122	55	19	203,745	109,530	5,031
	1982	121	67	63	615,426	553,140	31,919
	1983	122	97	80	306,767	285,320	28,587
	1984	117	51	37	140,927	122,514	13,968

Table 2. Comparison of assessment data for Cape Breton Island snow crab (Areas 2-6), 1978-84.

Area	Year	No. of active boats	No. of logbooks received	Landed statistics: area managers (kg)	Landed statistics: logbooks (kg)	Effort (standardized trap hauls)	Mean CPUE	Available biomass for season (MT)	Exploitation rate (%)	Standardized trap type
2, 3 & 4	1978	27	23	-	192,228	17,258	11.14	-	-	(1.2x0.9x0.8 m, wood)
(inshore)	1979	70	40	917,136	262,250	25,660	10.22	324.9	81	"
	1980	65	42	367,846	181,033	17,499	10.35	225.2	80	"
	1981	39	4	97,386	7,361	580	12.69	-	-	(1.5x1.5x0.5 m, steel)
	1982	41	28	252,209	100,161	13,971	7.17	153.0	65	(1.2x0.9x0.8 m, wood)
	1983	63	41	91,387	55,242	11,780	4.69	76.5	72	"
	1984	28	18	41,823	16,423	5,382	3.05	24.2	68	"
4	1978	*	4	-	203,966	4,916	41.49	-	-	(1.5x1.5x0.5 m, steel)
(offshore)	1979	*	16	*	507,569	10,546	48.13	790.0	64	"
	1980	*	4	*	39,800	827	48.13	-	-	"
	1981	*	-	*	-	-	-	-	-	"
	1982	*	10	*	91,377	2,875	31.78	-	-	"
	1983	*	6	*	16,790	1,454	11.55	-	-	"
	1984	*	2	*	14,557	1,159	12.56	28.3	51	"
5	1978	15	15	-	250,076	4,531	55.19	440.0	57	"
	1979	24	23	679,504	682,731	14,747	46.30	1185.0	58	"
	1980	24	21	395,855	324,786	7,341	44.24	543.0	60	"
	1981	11	10	90,463	81,819	2,835	28.86	-	-	"
	1982	19	18	300,145	298,469	8,848	33.73	356.9**	84	"
	1983	21	21	151,296	148,827	7,261	20.50	176.0**	85	"
	1984	10	6	45,215	41,295	2,336	17.68	55.3	75	"
6	1979	4	4	24,868	27,351	1,880	14.55	69.44	39	"
	1980	10	9	58,586	69,136	5,246	13.18	177.0	39	"
	1981	5	5	15,896	20,350	1,316	15.46	35.8	57	"
	1982	7	7	63,072	63,133	6,462	9.77	175.0	36	"
	1983	13	12	64,084	64,461	7,614	8.47	102.7	63	"
	1984	13	12	53,889	50,239	5,229	9.61	-	-	"
TOTAL	1978	46	42	-	646,270	26,705	24.20			All trap types combined
	1979	98	83	1,621,507	1,479,901	52,833	28.01			"
	1980	99	76	822,287	614,755	30,913	19.89			"
	1981	55	19	203,745	109,530	4,731	23.15			"
	1982	67	63	615,426	553,140	32,156	17.20			"
	1983	97	80	306,767	285,320	28,109	10.15			"
	1984	51	37	140,927	122,514	14,106	8.69			"

*Included in area 2, 3 & 4.
**From tagging estimate, all other estimates from Leslie analysis of logbook data.

Table 3. Catch and effort statistics from logbook data for the snow crab fishery in area 3 and part of 4, 1984.

Week period	Trap hauls			Catch (kg)	Cumulative catch (kg)	CPUE kg/trap haul (wooden traps)
	Steel traps (1.5x1.5x0.5 m)	Conical and wooden traps (1.2x0.9x0.8 m)	All traps converted into wooden traps			
22/7-28/7	297	240	540	1,702	851.0	3.15
29/7-4/8	207	1,234	1,444	6,222	4,813.0	4.31
5/8-11/8	120	1,446	1,544	4,910	10,379.0	3.18
12/8-18/8	30	1,244	1,282	2,833	14,250.5	2.21
19/8-25/8	-	304	304	450	15,892.0	1.48
26/8-1/9	-	188	188	230	16,232.0	1.22
2/9-8/9	-	40	40	51	16,372.5	1.28
9/9-15/9	-	40	40	25	16,410.5	0.63
Total	654	4,736	5,382	16,423	16,423.0	-

Table 4. Catch and effort statistics from logbook data for the snow crab fishery in area 4, 1984 (not including data from area 4 boats which fished adjacent to or in area 3).

Week period	Steel traps (1.5x1.5x0.5 m)	Catch (kg)	Cumulative catch (kg)	CPUE (kg/trap haul)
22/7-28/7	239	4,209	2,104.5	17.61
29/7-4/8	386	4,727	6,572.5	12.25
5/8-11/8	206	2,387	10,129.5	11.59
12/8-18/8	167	1,696	12,171.0	10.16
19/8-25/8	60	592	13,315.0	9.87
26/8-1/9	101	946	14,084.0	9.37
Total	1,159	14,557	14,557.0	-

Table 5. Catch and effort statistics from logbook data for the snow crab fishery in area 5, 1984.

Week period	Steel traps (1.5x1.5x0.5 m)	Conical traps	All traps converted into steel traps	Catch (kg)	Cumulative catch (kg)	CPUE (kg/trap haul)
22/7-28/7	150	78	190	5,895	2,947.5	31.08
29/7-4/8	226	122	333	9,447	10,618.5	28.39
5/8-11/8	281	92	390	7,233	18,958.0	18.55
12/8-18/8	385	127	573	9,522	27,336.0	16.61
19/8-25/8	225	66	319	3,823	34,008.0	11.99
26/8-1/9	193	130	397	4,151	37,995.5	10.45
2/9-8/9	48	25	62	608	40,375.0	9.83
9/9-15/9	72	-	72	616	40,987.0	8.56
Total	1,580	640	2,336	41,295	41,295.0	-

Table 6. Summary of mark-recapture data for male snow crabs tagged in area 5 with t-bar tags, 1982-84.

Date	1982 (Study)	1983 (Study)	Total
No. male crabs tagged	1958	1288	3246
1982 - No. recaptured	924 (47.2%)	-	924
No. measured	364	-	364
No. grown	13 (3.6%)	-	13 (3.6%)
1983 - No. recaptured	158	624 (48.4%)	782
No. measured	121	566	687
No. grown	5 (4.1%)	7 (1.2%)	12 (1.7%)
1984 - No. recaptured	17	94	111
No. measured	1	7	8
No. grown	0	1 (14.3%)	1 (12.5%)

Table 7. Catch and effort statistics from logbook data for the snow crab fishery in area 6, 1984.

Week period	Steel traps (1.5x1.5x0.5 m)	Catch (kg)	Cumulative catch (kg)	CPUE (kg/trap haul)
1/8-4/8	740	8,427	4,213.5	11.39
5/8-11/8	1,179	12,462	14,658.0	10.57
12/8-18/8	763	7,952	24,865.0	10.42
19/8-25/8	621	5,508	31,595.0	8.87
26/8-1/9	510	4,508	36,603.0	8.84
2/9-8/9	504	3,677	40,695.5	7.30
9/9-15/9	376	2,795	43,931.5	7.43
16/9-22/9	230	1,877	46,267.5	8.16
23/9-29/9	306	3,033	48.722.5	9.91
Total	5,229	50,239	50,239.0	9.61

Fig. 1. 1984 Cape Breton Island snow crab fishing areas and landings.

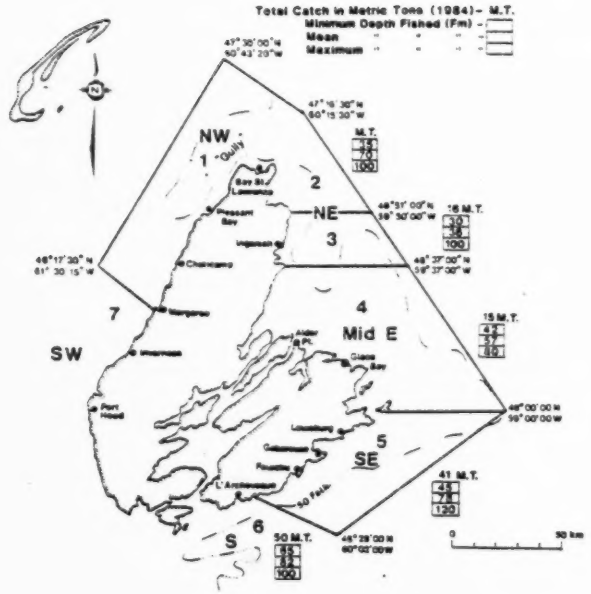


Fig. 2. Distribution of snow crab fishing effort off the Atlantic coast of Cape Breton Island during the 1984 season, as derived from logbook data.

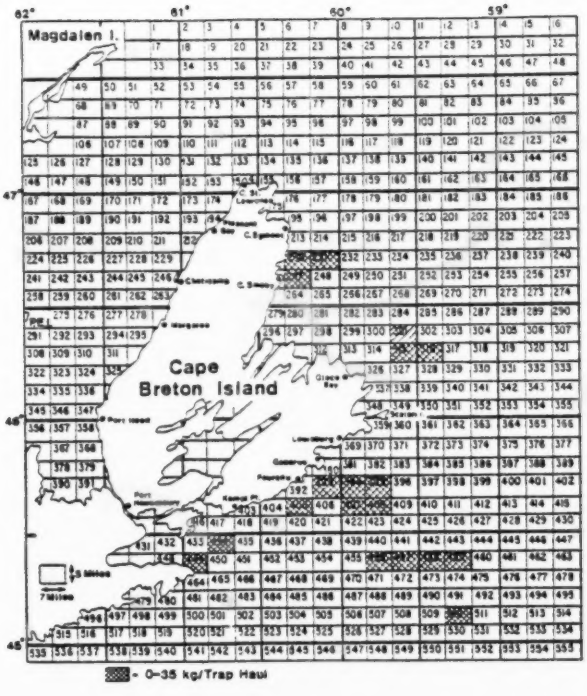


Fig. 3. Leslie graph of cumulative weekly landings against CPUE, from logbook data, for modified (inshore) area 3/4 in 1984. (Note: comparative CPUE pattern is shown for 1983).

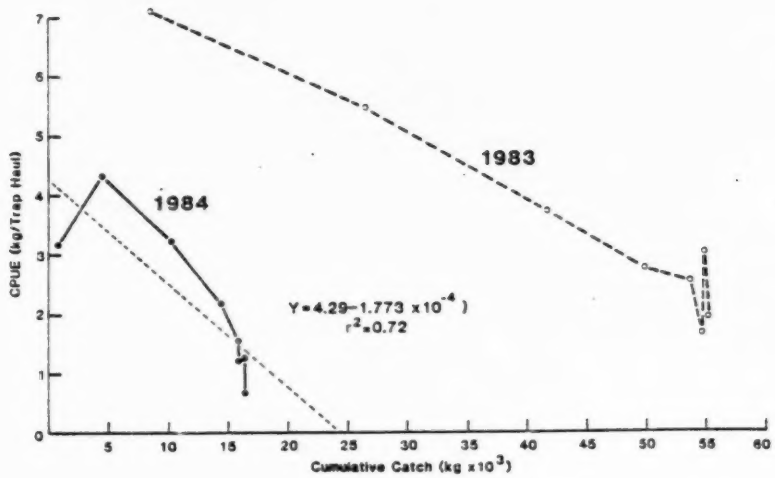


Fig. 4. Leslie graph of cumulative weekly landings against CPUE, from logbook data, for modified (offshore) area 4 in 1984.

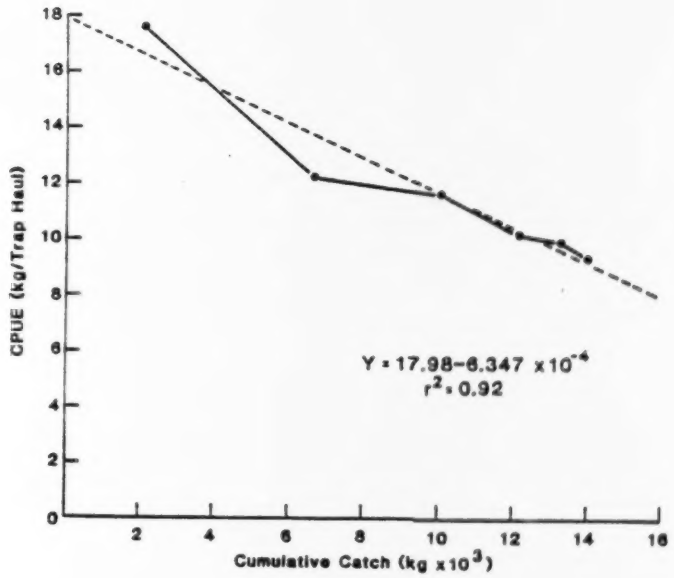


Fig. 5. Size-frequency histograms for male snow crabs sampled from commercial vessels in area 3 during the 1984 fishing season.

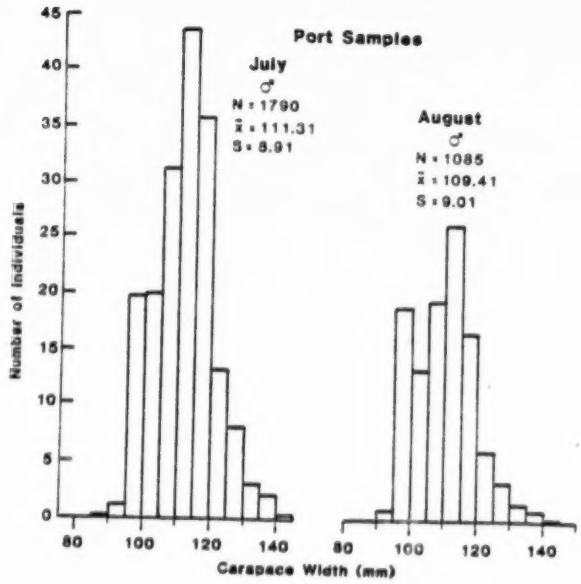


Fig. 6. Percentage frequency of occurrence of shell states for male snow crabs throughout the 1984 fishing season in areas 3 and 5.

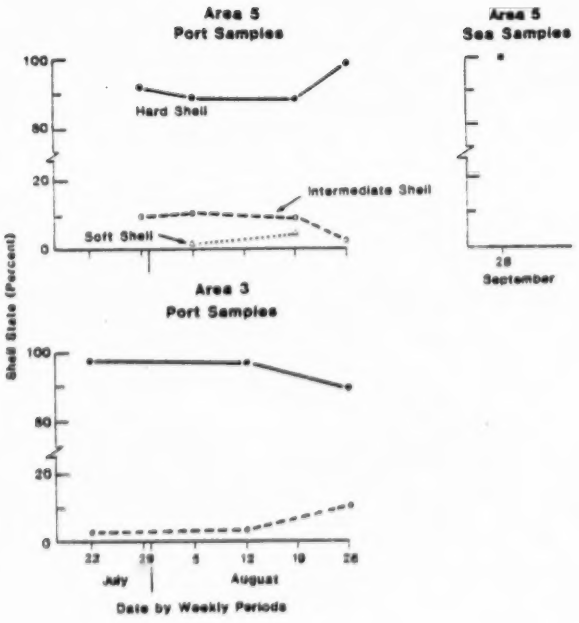


Fig. 7. Size-frequency histograms for male snow crabs sampled from commercial vessels in area 5 during the 1984 fishing season.

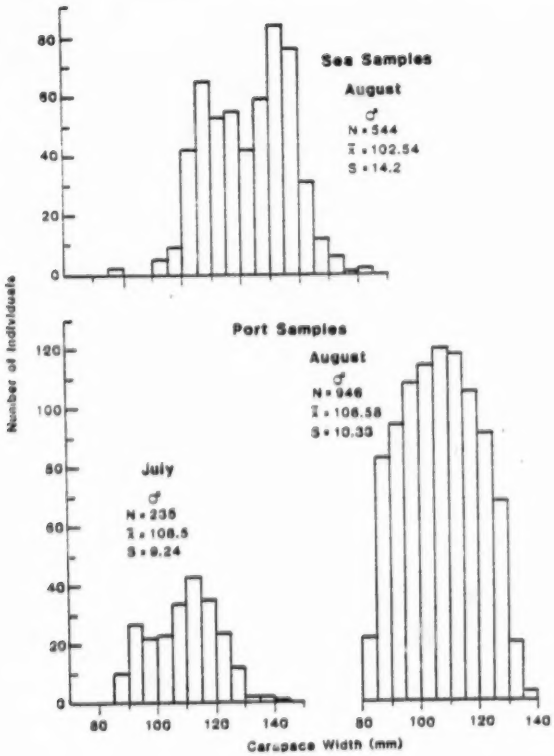
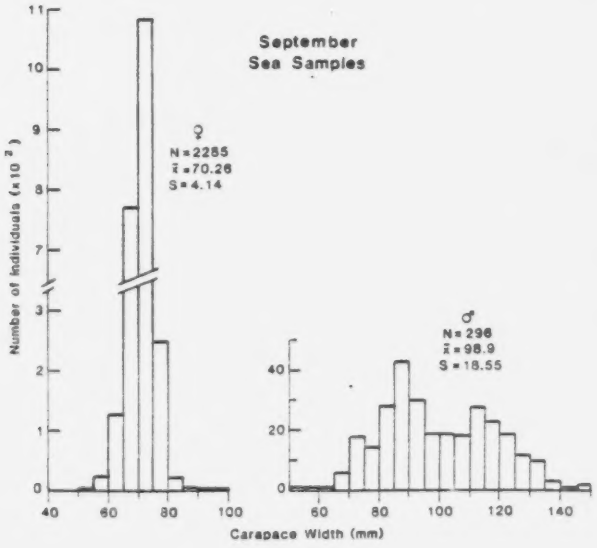


Fig. 8. Size-frequency histograms for male and mature female snow crabs sampled from a commercial vessel under charter in area 5, September 27-29, 1984. Separate histograms are displayed for ovigerous and non-ovigerous females.



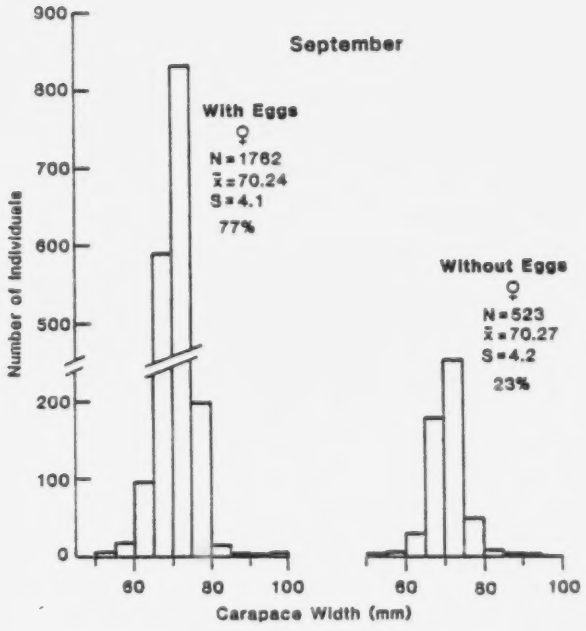


Fig. 9. Historical monthly mean carapace widths for male snow crabs from port and at-sea sampling in area 5.

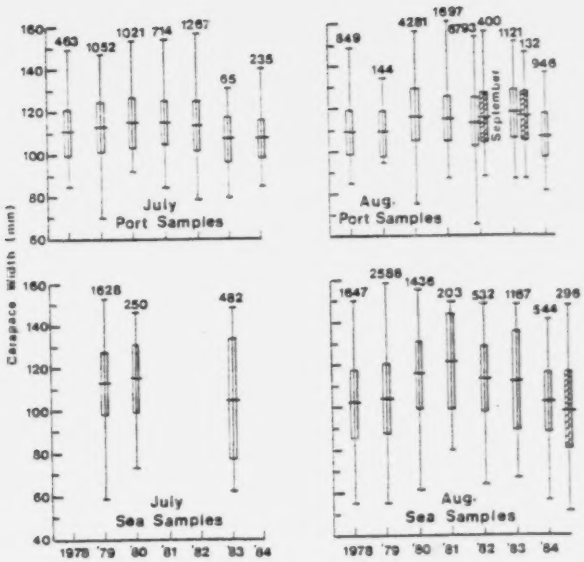


Fig. 10. CPUE, from logbook data, at 3-d intervals through the 1984 season for all 5 vessels in area 5 returning logbooks.

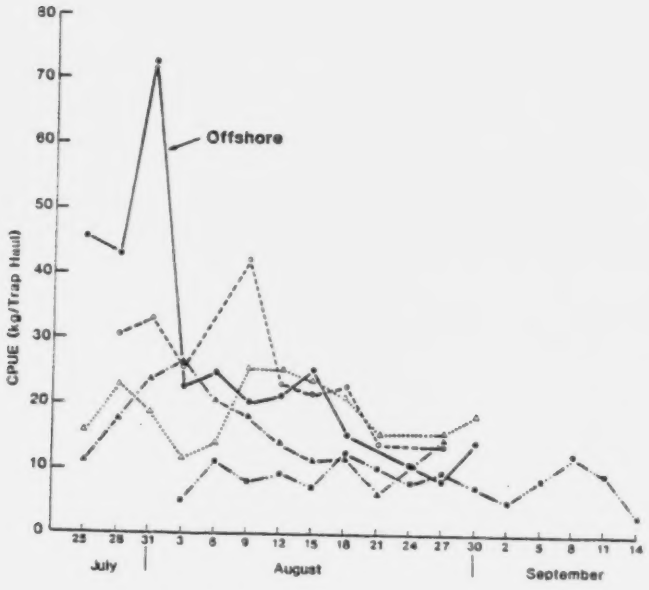


Fig. 11. Leslie graph of cumulative weekly landings against CPUE, from logbook data, for area 5 in 1984 (Note: comparative CPUE pattern is shown for 1983).

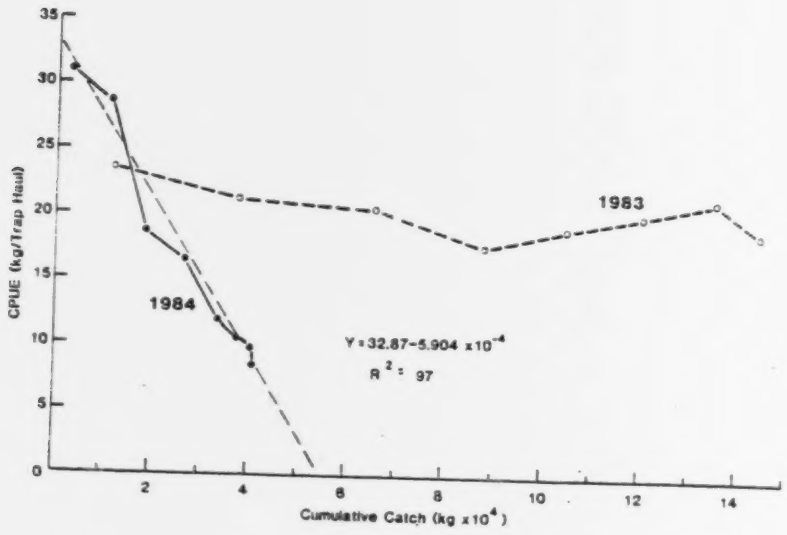


Fig. 12. Historical trends of CPUE against cumulative catch in area 5 from logbook data.

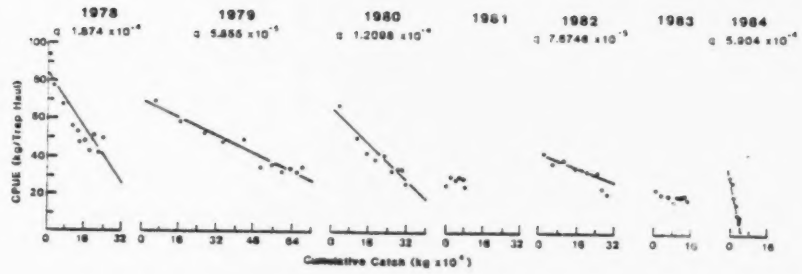


Fig. 13. Size-frequency and reproductive state of mature females tagged in area 5, September 27-29, 1984.

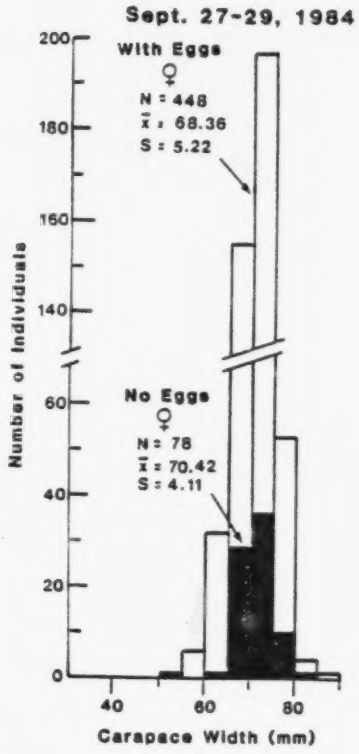


Fig. 14. Percentage of ovigerous mature female snow crabs by monthly periods for area 5 from 1978-84.

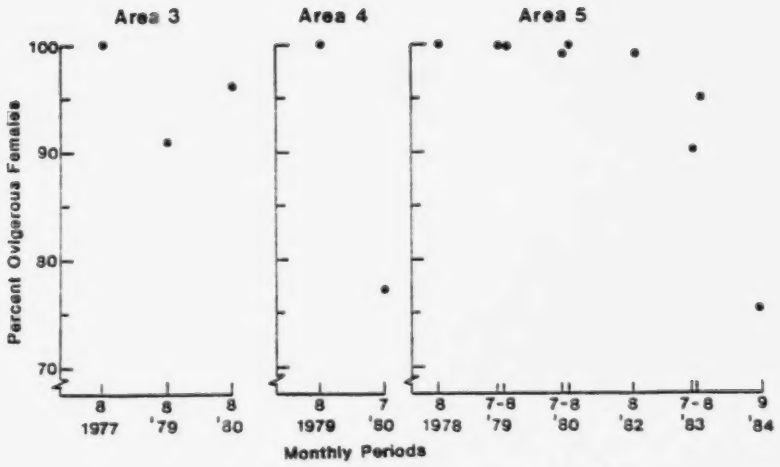


Fig. 15. Size-frequency histogram for male snow crabs sampled in-port from commercial vessels in area 6, August 1984.

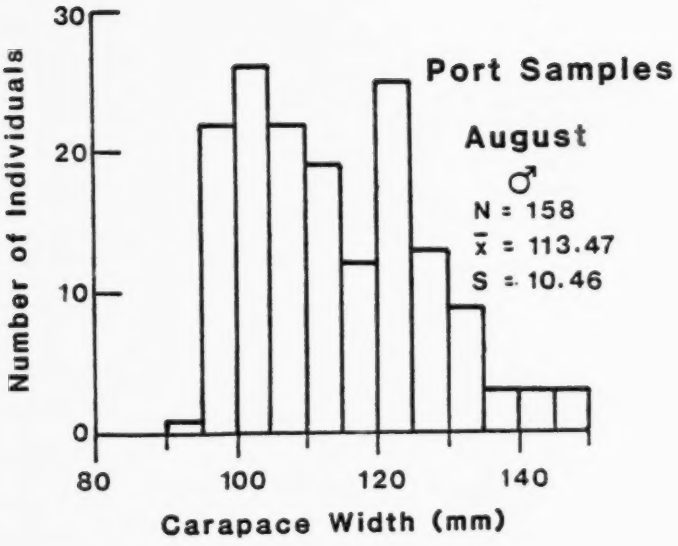


Fig. 16. Graphs of cumulative weekly landings against CPUE, from logbook data for area 6 in 1983 and 1984.